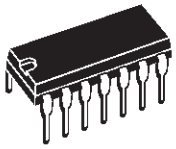
查询LM124供应商

# LM124
# LM224 - LM324

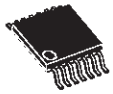
## LOW POWER QUAD OPERATIONAL AMPLIFIERS

- WIDE GAIN BANDWIDTH : 1.3MHz
- INPUT COMMON-MODE VOLTAGE RANGE INCLUDES GROUND
- LARGE VOLTAGE GAIN : 100dB
- VERY LOW SUPPLY CURRENT/AMPLI : 375µA
- LOW INPUT BIAS CURRENT : 20nA
- LOW INPUT OFFSET VOLTAGE : 5mV max.
  (for more accurate applications, use the equivalent parts LM124A-LM224A-LM324A which feature 3mV max)
- LOW INPUT OFFSET CURRENT : 2nA
- WIDE POWER SUPPLY RANGE :
  SINGLE SUPPLY : +3V TO +30V
  DUAL SUPPLIES : ±1.5V TO ±15V



**N**
**DIP14**
(Plastic Package)

**D**
**SO14**
(Plastic Micropackage)



**P**
**TSSOP14**
(Thin Shrink Small Outline Package)

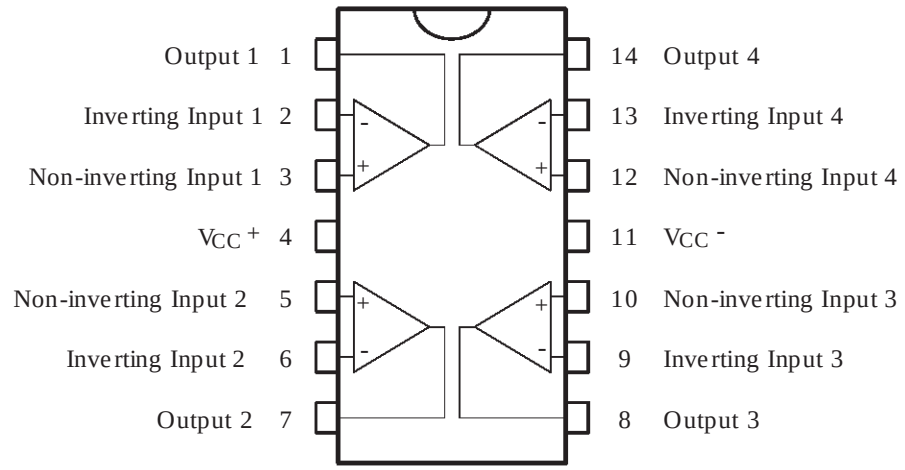
### DESCRIPTION

These circuits consist of four independent, high gain, internally frequency compensated operational amplifiers . They operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

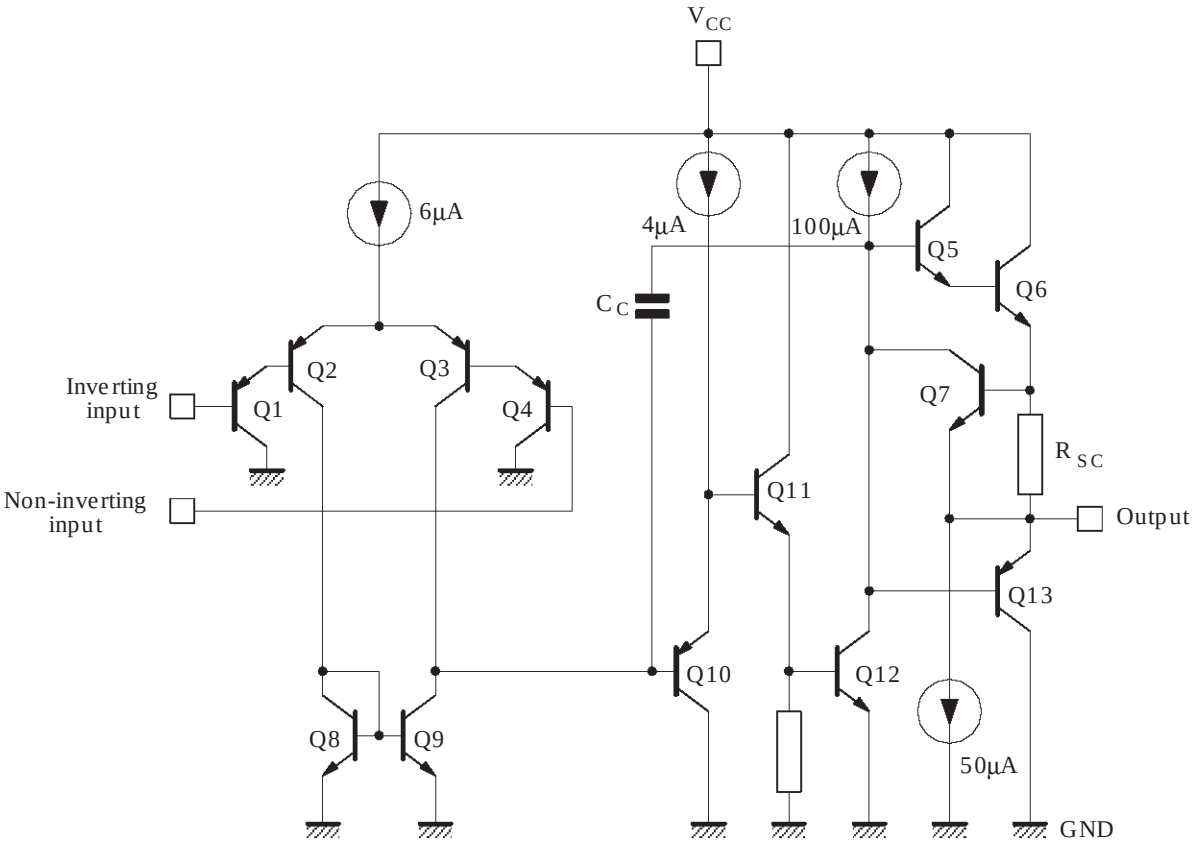
### ORDER CODES

| Part Number | Temperature Range | Package | | |
|---|---|---|---|---|
| | | N | D | P |
| LM124 | -55°C, +125°C | • | • | • |
| LM224 | -40°C, +105°C | • | • | • |
| LM324 | 0°C, +70°C | • | • | • |
| **Example :** LM224N | | | | |

### PIN CONNECTIONS (top view)



## SCHEMATIC DIAGRAM (1/4 LM124)




## ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | LM124 | LM224 | LM324 | Unit |
|---|---|---|---|---|---|
| $V_{cc}$ | Supply Voltage | ±16 or 32 | | | V |
| $V_i$ | Input Voltage | -0.3 to +32 | | | V |
| $V_{id}$ | Differential Input Voltage - (*) | +32 | +32 | +32 | V |
| $P_{tot}$ | Power Dissipation N Suffix<br>D Suffix | 500<br>- | 500<br>400 | 500<br>400 | mW<br>mW |
| - | Output Short-circuit Duration - (note 1) | Infinite | | | |
| $I_{in}$ | Input Current – (note 6) | 50 | 50 | 50 | mA |
| $T_{oper}$ | Operating Free Air Temperature Range | -55 to +125 | -40 to +105 | 0 to +70 | °C |
| $T_{stg}$ | Storage Temperature Range | -65 to +150 | -65 to +150 | -65 to +150 | °C |

## ELECTRICAL CHARACTERISTICS

$V_{CC}^+$ = +5V, $V_{CC}^-$ = Ground, $V_O$ = 1.4V, $T_{amb}$ = +25°C (unless otherwise specified)

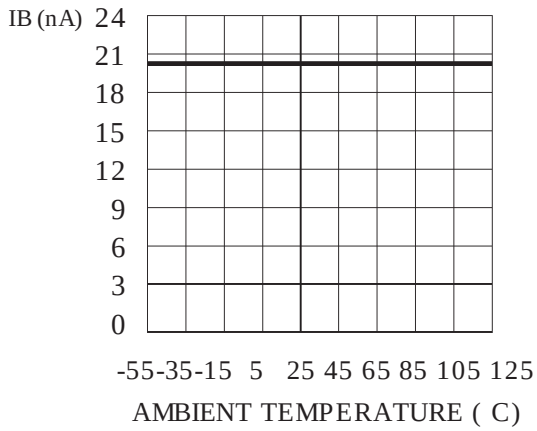
| Symbol | Parameter | LM124 - LM224 - LM324 | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| $V_{io}$ | Input Offset Voltage (note 3)<br>$T_{amb}$ = +25°C<br>LM324<br>$T_{min.} \le T_{amb} \le T_{max}$.<br>LM324 | | 2 | 5<br>7<br>7<br>9 | mV |
| $I_{io}$ | Input Offset Current<br>$T_{amb}$ = +25°C<br>$T_{min.} \le T_{amb} \le T_{max}$. | | 2 | 30<br>100 | nA |
| $I_{ib}$ | Input Bias Current (note 2)<br>$T_{amb}$ = +25°C<br>$T_{min.} \le T_{amb} \le T_{max}$. | | 20 | 150<br>300 | nA |
| $A_{vd}$ | Large Signal Voltage Gain<br>($V_{CC}^+$ = +15V, $R_L$ = 2kΩ, $V_O$ = 1.4V to 11.4V)<br>$T_{amb}$ = +25°C<br>$T_{min.} \le T_{amb} \le T_{max}$. | <br>50<br>25 | <br>100 | | V/mV |
| SVR | Supply Voltage Rejection Ratio ($R_S \le 10k\Omega$)<br>($V_{CC}^+$ = 5V to 30V)<br>$T_{amb}$ = +25°C<br>$T_{min.} \le T_{amb} \le T_{max}$. | <br>65<br>65 | <br>110 | | dB |
| $I_{CC}$ | Supply Current, all Amp, no load<br>$T_{amb}$ = +25°C $V_{CC}$ = +5V<br>$V_{CC}$ = +30V<br>$T_{min.} \le T_{amb} \le T_{max}$. $V_{CC}$ = +5V<br>$V_{CC}$ = +30V | | <br>0.7<br>1.5<br>0.8<br>1.5 | <br>1.2<br>3<br>1.2<br>3 | mA |
| $V_{icm}$ | Input Common Mode Voltage Range<br>($V_{CC}$ = +30V) - (note 4)<br>$T_{amb}$ = +25°C<br>$T_{min.} \le T_{amb} \le T_{max}$. | <br>0<br>0 | | <br>$V_{CC}$ -1.5<br>$V_{CC}$ -2 | V |
| CMR | Common-mode Rejection Ratio ($R_S \le 10k\Omega$)<br>$T_{amb}$ = +25°C<br>$T_{min.} \le T_{amb} \le T_{max}$ | <br>70<br>60 | <br>80 | | dB |
| $I_{source}$ | Output Current Source ($V_{id}$ = +1V)<br>$V_{CC}$ = +15V, $V_o$ = +2V | <br>20 | <br>40 | <br>70 | mA |
| $I_{sink}$ | Output Sink Current ($V_{id}$ = -1V)<br>$V_{CC}$ = +15V, $V_o$ = +2V<br>$V_{CC}$ = +15V, $V_o$ = +0.2V | <br>10<br>12 | <br>20<br>50 | | <br>mA<br>µA |

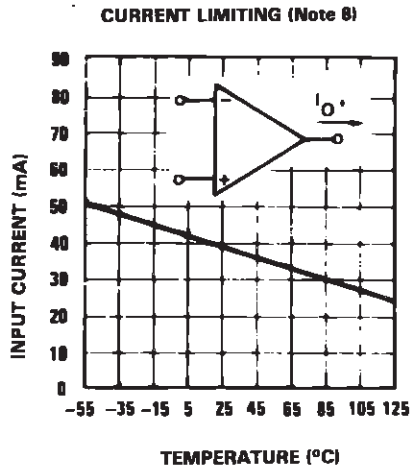
## ELECTRICAL CHARACTERISTICS (continued)

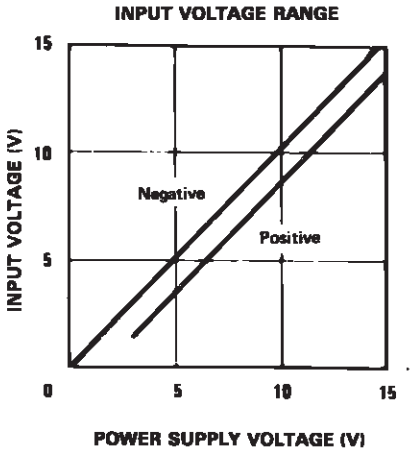
| Symbol | Parameter | LM124 - LM224 - LM324 | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| $V_{OH}$ | High Level Output Voltage<br>($V_{CC}$ = +30V)<br>$T_{amb}$ = +25°C $R_L$ = 2kΩ<br>$T_{min.} \le T_{amb} \le T_{max.}$<br>$T_{amb}$ = +25°C $R_L$ = 10kΩ<br>$T_{min.} \le T_{amb} \le T_{max.}$<br>($V_{CC}$ = +5V, $R_L$ = 2kΩ)<br>$T_{amb}$ = +25°C<br>$T_{min.} \le T_{amb} \le T_{max.}$ | <br><br>26<br>26<br>27<br>27<br><br>3.5<br>3 | <br><br>27<br><br>28<br><br><br><br> | <br><br><br><br><br><br><br><br> | V |
| $V_{OL}$ | Low Level Output Voltage ($R_L$ = 10kΩ)<br>$T_{amb}$ = +25°C<br>$T_{min.} \le T_{amb} \le T_{max.}$ | | <br>5 | <br>20<br>20 | mV |
| SR | Slew Rate<br>$V_{CC}$ = 15V, $V_I$ = 0.5 to 3V, $R_L$ = 2kΩ, $C_L$ = 100pF, unity gain) | | <br>0.4 | | V/µs |
| GBP | Gain Bandwidth Product<br>$V_{CC}$ = 30V, f = 100kHz, $V_{in}$ = 10mV<br>$R_L$ = 2kΩ, $C_L$ = 100pF | | <br>1.3 | | MHz |
| THD | Total Harmonic Distortion<br>f = 1kHz, $A_V$ = 20dB, $R_L$ = 2kΩ, $V_O$ = $2V_{pp}$<br>$C_L$ = 100pF, $V_{CC}$ = 30V | | <br>0.015 | | % |
| $e_n$ | Equivalent Input Noise Voltage<br>f = 1kHz, $R_s$ = 100Ω, $V_{CC}$ = 30V | | <br>40 | | $\frac{nV}{\sqrt{Hz}}$ |
| $DV_{io}$ | Input Offset Voltage Drift | | 7 | 30 | µV/°C |
| $DI_{IO}$ | Input Offset Current Drift | | 10 | 200 | pA/°C |
| $V_O1/V_O2$ | Channel Separation (note 5)<br>1kHz ≤ f ≤ 20kHz | | <br>120 | | dB |

**Notes :**
1. Short-circuits from the output to $V_{CC}$ can cause excessive heating if $V_{CC}$ > 15V. The maximum output current is approximately 40mA independent of the magnitude of $V_{CC}$. Destructive dissipation can result from simultaneous short-circuit on all amplifiers.
2. The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.
3. $V_o$ = 1.4V, $R_s$ = 0Ω, 5V < $V_{CC}^+$ < 30V, 0 < $V_{ic}$ < $V_{CC}^+$ - 1.5V
4. The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is $V_{CC}^+$ - 1.5V, but either or both inputs can go to +32V without damage.
5. Due to the proximity of external components insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance increases at higher frequences.
6. This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward biased and thereby acting as input diodes clamps. In addition to this diode action, there is also NPN parasitic action on the IC chip. this transistor action can cause the output voltages of the Op-amps to go to the $V_{CC}$ voltage level (or to ground for a large overdrive) for the time duration than an input is driven negative.
   This is not destructive and normal output will set up again for input voltage higher than -0.3V.

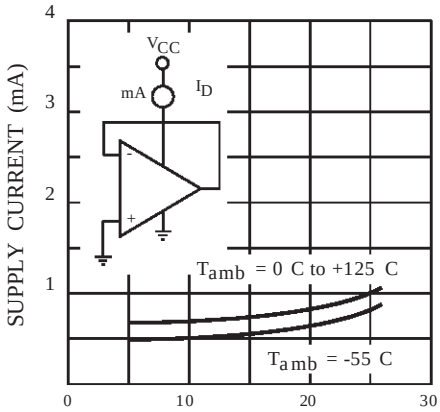
INPUT BIAS CURRENT
versus AMBIENT TEMPERATURE

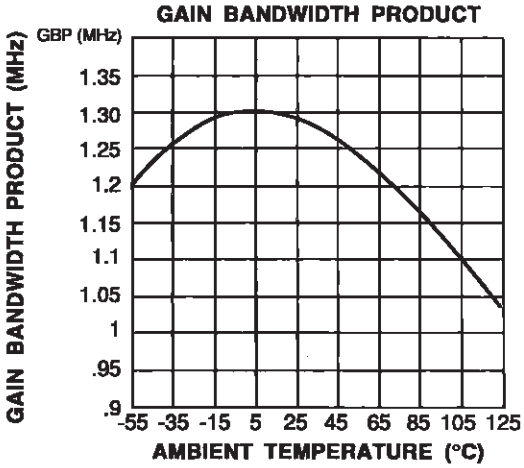


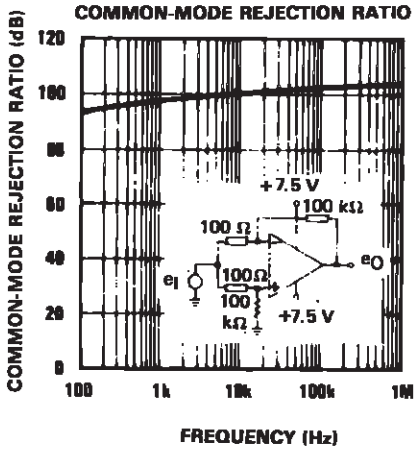



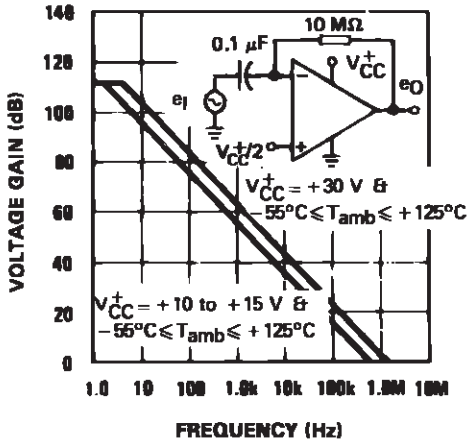

SUPPLY CURRENT



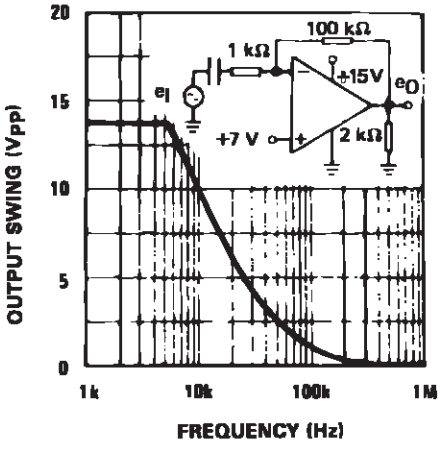



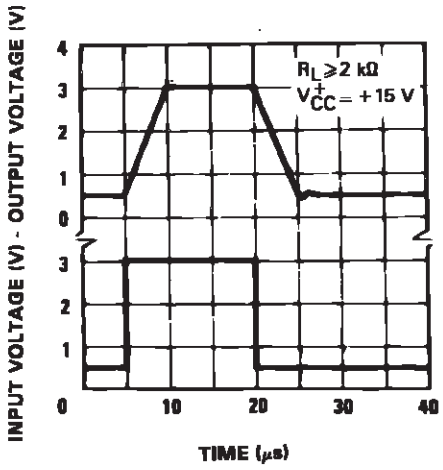
**OPEN LOOP FREQUENCY RESPONSE**



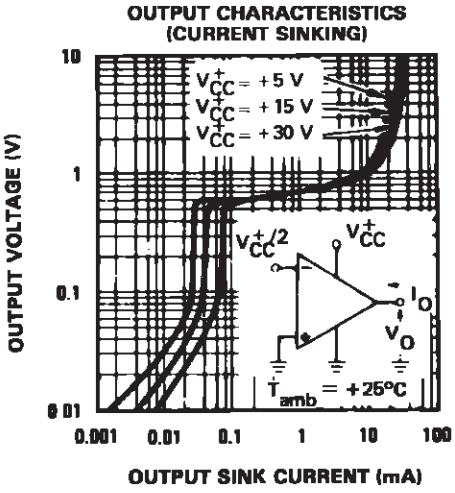

**LARGE SIGNAL FREQUENCY RESPONSE**



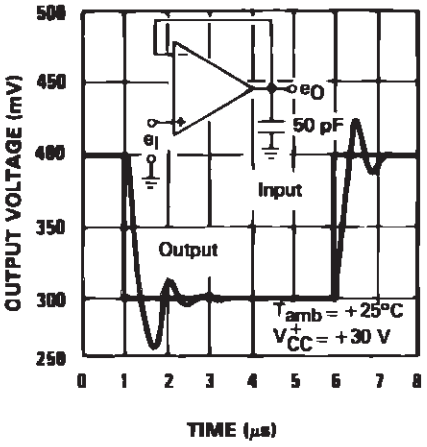

**VOLTAGE FOLLOWER PULSE RESPONSE**



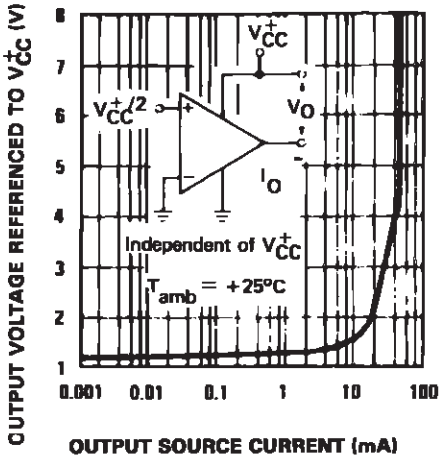

**OUTPUT CHARACTERISTICS (CURRENT SINKING)**

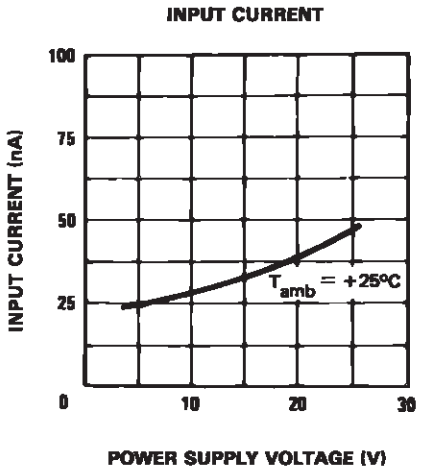


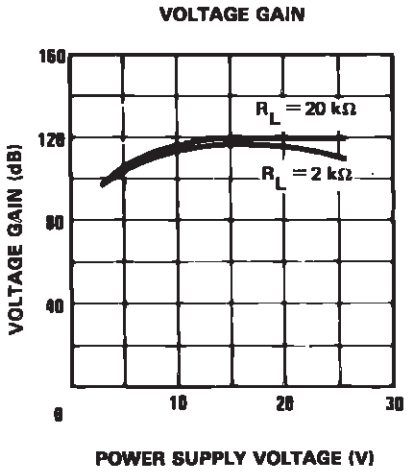

**VOLTAGE FOLLOWER PULSE RESPONSE (SMALL SIGNAL)**

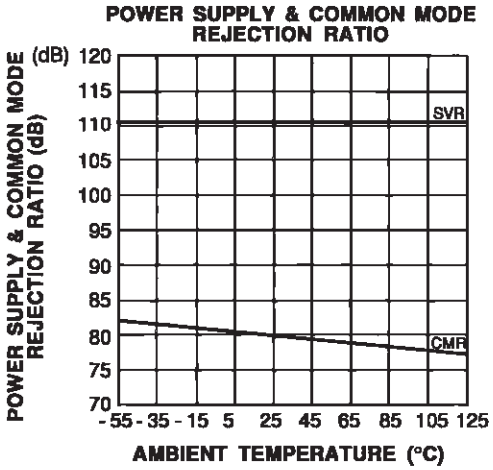


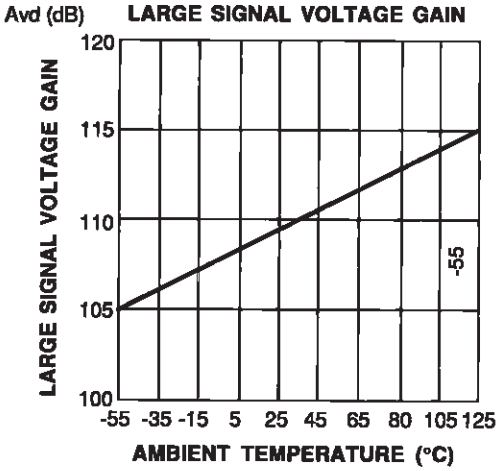

**OUTPUT CHARACTERISTICS (CURRENT SOURCING)**





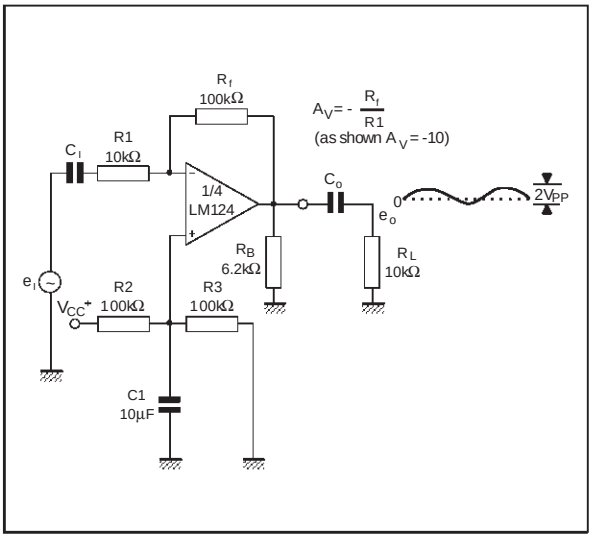



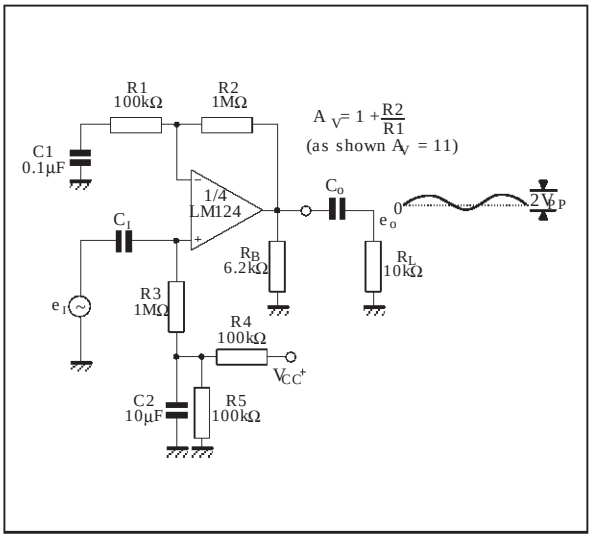




## TYPICAL SINGLE - SUPPLY APPLICATIONS

AC COUPLED INVERTING AMPLIFIER

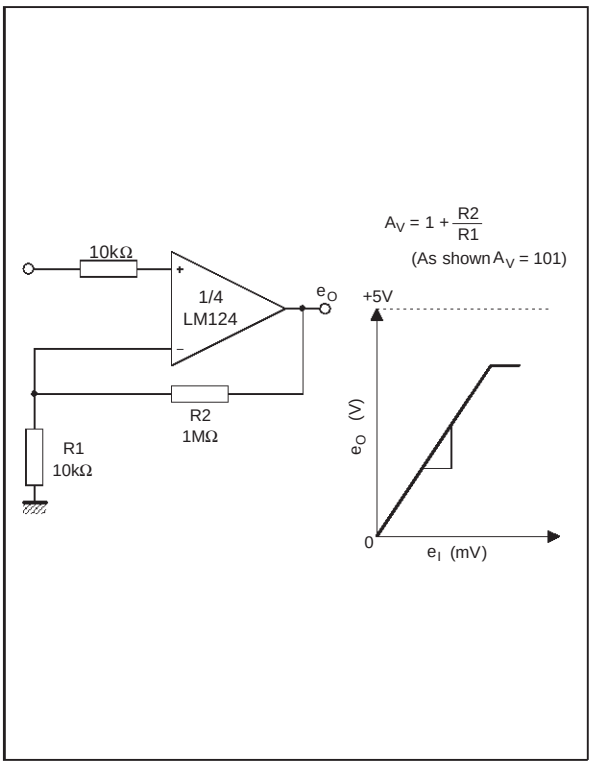



AC COUPLED NON-INVERTING AMPLIFIER

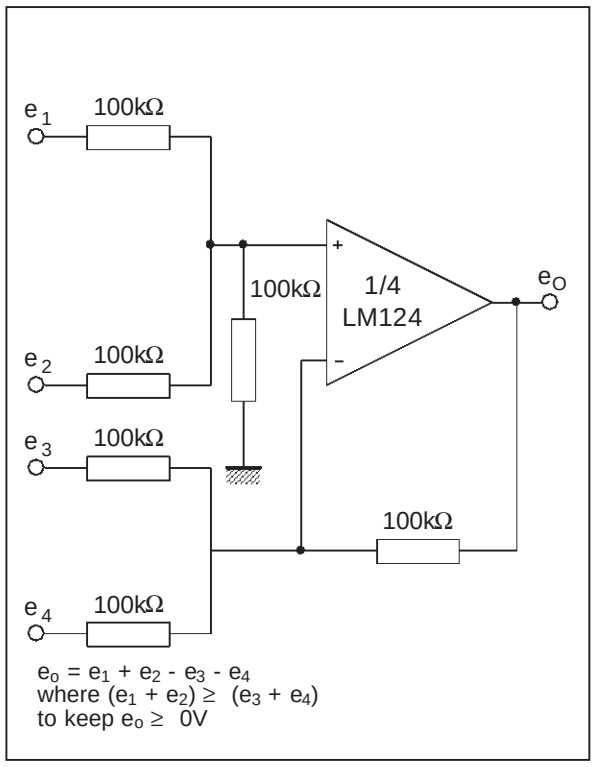


## TYPICAL SINGLE - SUPPLY APPLICATIONS

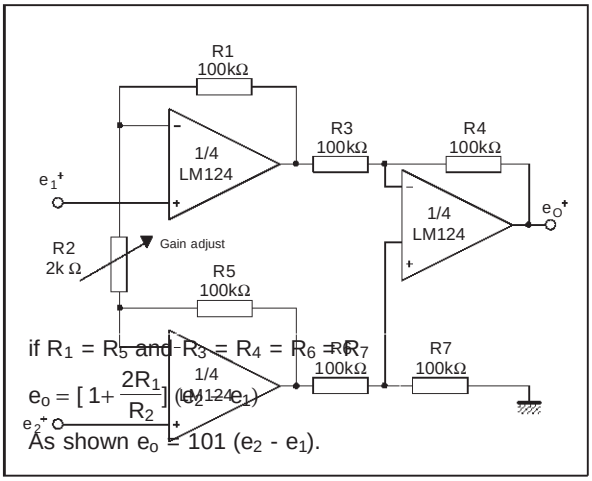
NON-INVERTING DC GAIN



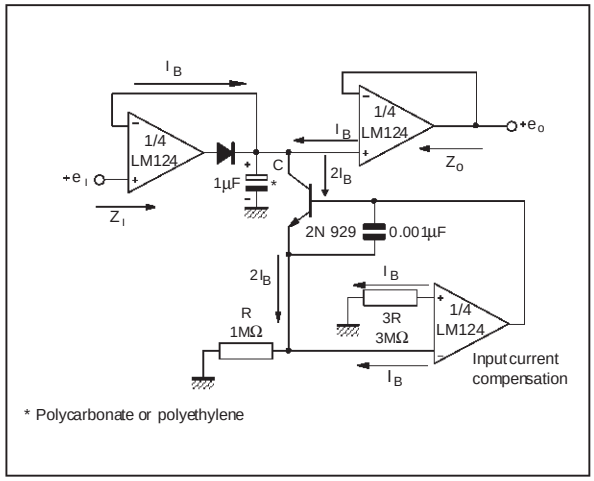

DC SUMMING AMPLIFIER



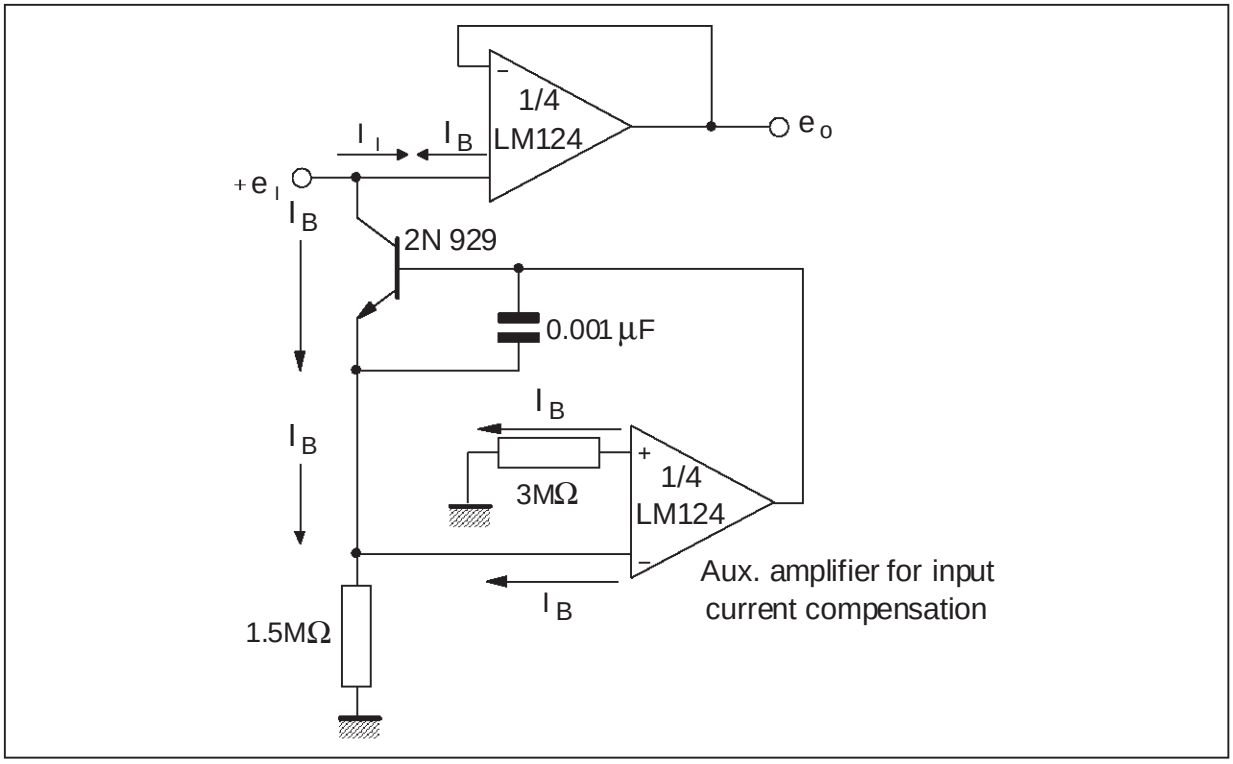

HIGH INPUT Z ADJUSTABLE GAIN DC INSTRUMENTATION AMPLIFIER




LOW DRIFT PEAK DETECTOR

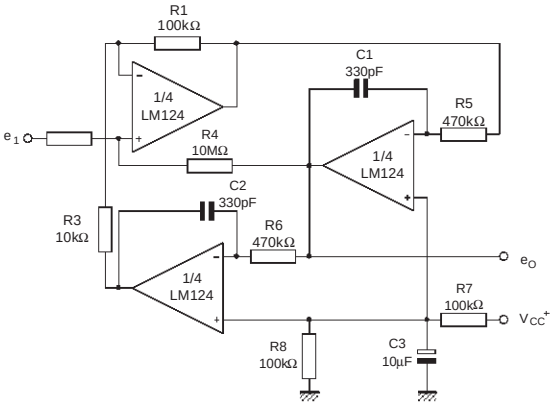


USING SYMMETRICAL AMPLIFIERS TO REDUCE INPUT CURRENT (GENERAL CONCEPT)



## TYPICAL SINGLE - SUPPLY APPLICATIONS

ACTIVER BANDPASS FILTER




$F_O$ = 1kHz

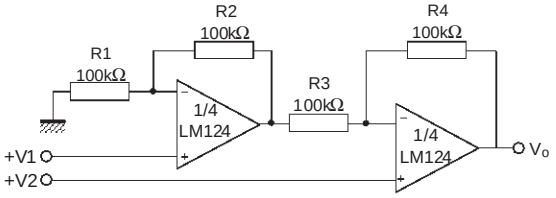
Q = 50

$A_V$ = 100 (40dB)

HIGH INPUT Z, DC DIFFERENTIAL AMPLIFIER

For $\frac{R_1}{R_2} = \frac{R_4}{R_3}$

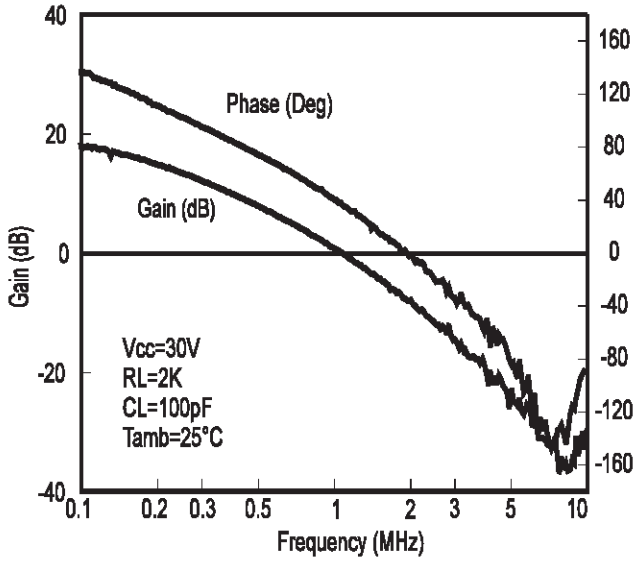
(CMRR depends on this resistor ratio match)




$e_o\ (1+\frac{R_4}{R_3})\ (e_2 - e_1)$

As shown $e_o = (e_2 - e_1)$

VOLTAGE GAIN AND PHASE vs FREQUENCY



- LARGE VOLTAGE GAIN : 100dB
- VERY LOW SUPPLY CURRENT/AMPLI : 375µA
- LOW INPUT BIAS CURRENT : 20nA
- LOW INPUT OFFSET VOLTAGE : 2mV
- LOW INPUT OFFSET CURRENT : 2nA
- WIDE POWER SUPPLY RANGE :
  SINGLE SUPPLY : +3V to +30V
  DUAL SUPPLIES : ±1.5V to ±15V

**Applies to : LM124-LM224-LM324**

```
** Standard Linear Ics Macromodels, 1993.
** CONNECTIONS :
* 1 INVERTING INPUT
* 2 NON-INVERTING INPUT
* 3 OUTPUT
* 4 POSITIVE POWER SUPPLY
* 5 NEGATIVE POWER SUPPLY

.SUBCKT LM124 1 3 2 4 5 (analog)
*************************************************************
.MODEL MDTH D IS=1E-8 KF=3.104131E-15 CJO=10F
* INPUT STAGE
CIP 2 5 1.000000E-12
CIN 1 5 1.000000E-12
EIP 10 5 2 5 1
EIN 16 5 1 5 1
RIP 10 11 2.600000E+01
RIN 15 16 2.600000E+01
RIS 11 15 2.003862E+02
DIP 11 12 MDTH 400E-12
DIN 15 14 MDTH 400E-12
VOFP 12 13 DC 0
VOFN 13 14 DC 0
IPOL 13 5 1.000000E-05
CPS 11 15 3.783376E-09
DINN 17 13 MDTH 400E-12
VIN 17 5 0.000000e+00
DINR 15 18 MDTH 400E-12
VIP 4 18 2.000000E+00
FCP 4 5 VOFP 3.400000E+01
FCN 5 4 VOFN 3.400000E+01
FIBP 2 5 VOFN 2.000000E-03
FIBN 5 1 VOFP 2.000000E-03
* AMPLIFYING STAGE
FIP 5 19 VOFP 3.600000E+02
FIN 5 19 VOFN 3.600000E+02
RG1 19 5 3.652997E+06
RG2 19 4 3.652997E+06
CC 19 5 6.000000E-09
DOPM 19 22 MDTH 400E-12
DONM 21 19 MDTH 400E-12
HOPM 22 28 VOUT 7.500000E+03
VIPM 28 4 1.500000E+02
HONM 21 27 VOUT 7.500000E+03
VINM 5 27 1.500000E+02
EOUT 26 23 19 5 1
VOUT 23 5 0
ROUT 26 3 20
COUT 3 5 1.000000E-12
DOP 19 25 MDTH 400E-12
VOP 4 25 2.242230E+00
DON 24 19 MDTH 400E-12
VON 24 5 7.922301E-01
.ENDS
```

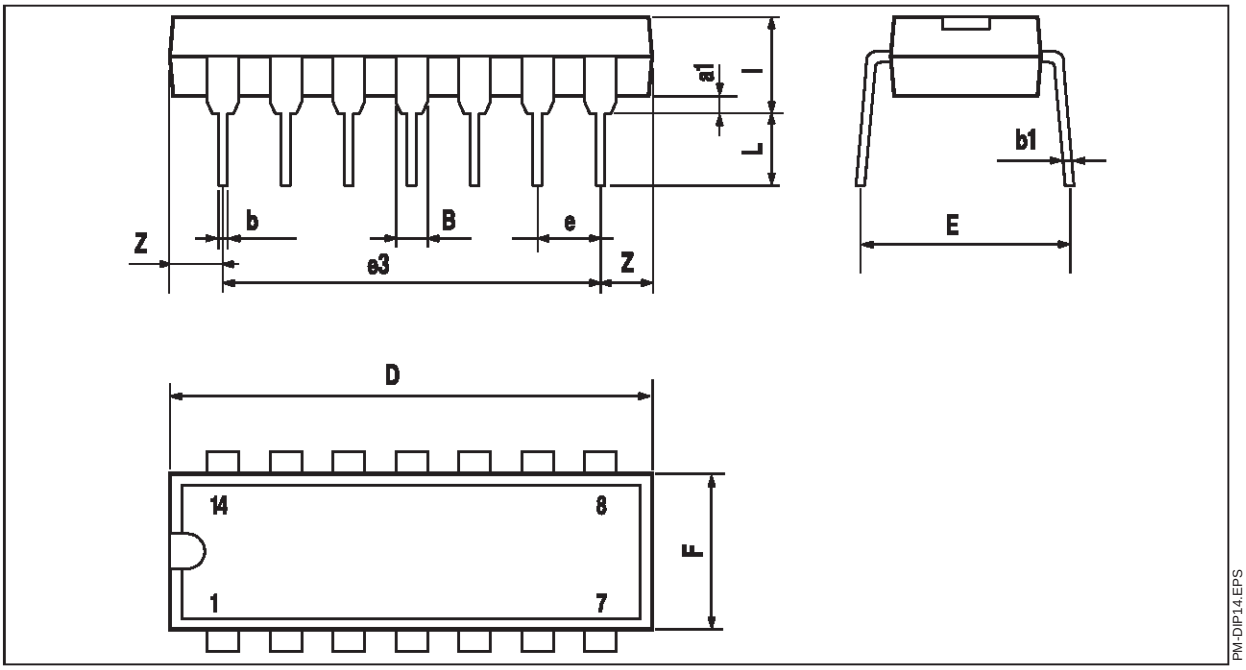
**ELECTRICAL CHARACTERISTICS**

$V_{CC}^+$ = +5V, $V_{CC}^-$ = 0V, $T_{amb}$ = 25°C (unless otherwise specified)

| Symbol | Conditions | Value | Unit |
|---|---|---|---|
| $V_{io}$ | | 0 | mV |
| $A_{vd}$ | $R_L$ = 2kΩ | 100 | V/mV |
| $I_{CC}$ | No load, per operator | 350 | µA |
| $V_{icm}$ | | -15 to +13.5 | V |
| $V_{OH}$ | $R_L$ = 2kΩ ($V_{CC}^+$ = 15V) | +13.5 | V |
| $V_{OL}$ | RL = 10kΩ | 5 | mV |
| $I_{OS}$ | $V_O$ = +2V, $V_{CC}$ = +15V | +40 | mA |
| GBP | $R_L$ = 2kΩ, $C_L$ = 100pF | 1.3 | MHz |
| SR | $R_L$ = 2kΩ, $C_L$ = 100pF | 0.4 | V/µs |

## PACKAGE MECHANICAL DATA

14 PINS - PLASTIC DIP

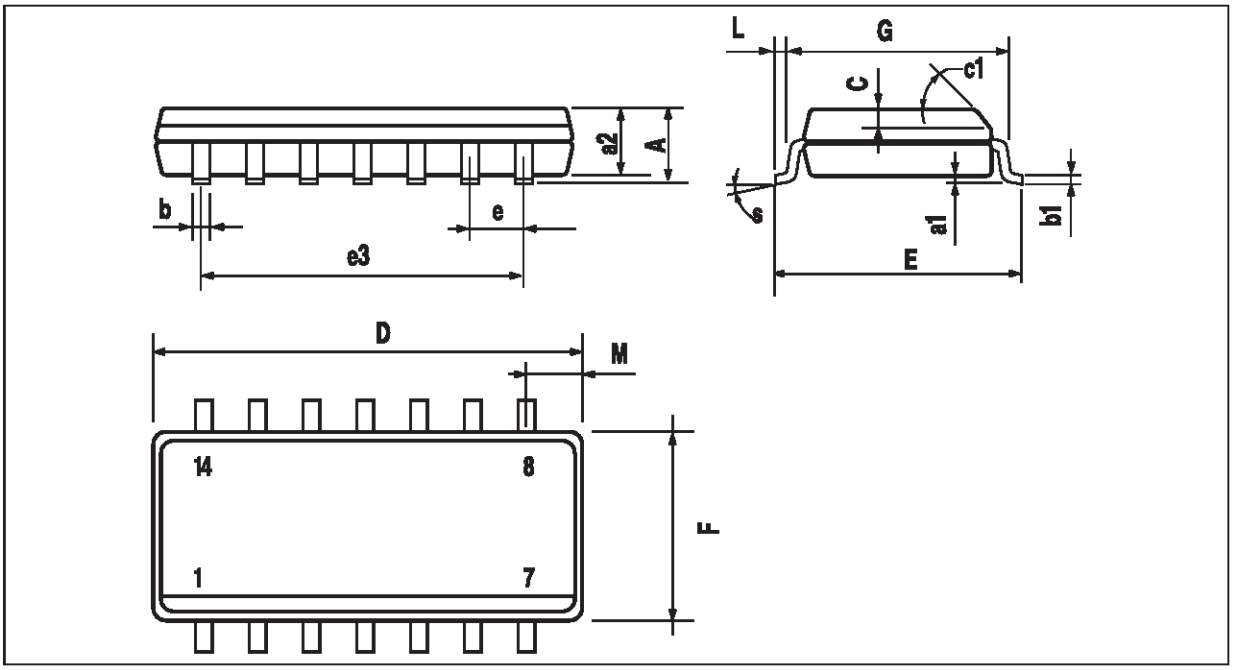



| Dimensions | Millimeters | | | Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| a1 | 0.51 | | | 0.020 | | |
| B | 1.39 | | 1.65 | 0.055 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 0.335 | |
| e | | 2.54 | | | 0.100 | |
| e3 | | 15.24 | | | 0.600 | |
| F | | | 7.1 | | | 0.280 |
| i | | | 5.1 | | | 0.201 |
| L | | 3.3 | | | 0.130 | |
| Z | 1.27 | | 2.54 | 0.050 | | 0.100 |

DIP14.TBL

## PACKAGE MECHANICAL DATA

14 PINS - PLASTIC MICROPACKAGE (SO)

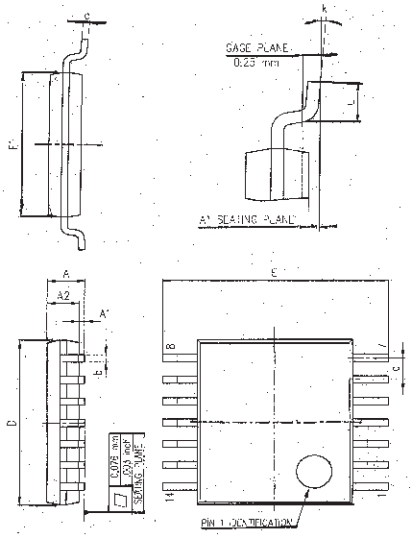



| Dimensions | Millimeters | | | Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.75 | | | 0.069 |
| a1 | 0.1 | | 0.2 | 0.004 | | 0.008 |
| a2 | | | 1.6 | | | 0.063 |
| b | 0.35 | | 0.46 | 0.014 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | | 0.5 | | | 0.020 | |
| c1 | $45^o$ (typ.) | | | | | |
| D | 8.55 | | 8.75 | 0.336 | | 0.334 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 7.62 | | | 0.300 | |
| F | 3.8 | | 4.0 | 0.150 | | 0.157 |
| G | 4.6 | | 5.3 | 0.181 | | 0.208 |
| L | 0.5 | | 1.27 | 0.020 | | 0.050 |
| M | | | 0.68 | | | 0.027 |
| S | $8^o$ (max.) | | | | | |

SO14.TBL

## PACKAGE MECHANICAL DATA

14 PINS - THIN SHRINK SMALL OUTLINE PACKAGE




| Dim. | Millimeters | | | Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.20 | | | 0.05 |
| A1 | 0.05 | | 0.15 | 0.01 | | 0.006 |
| A2 | 0.80 | 1.00 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.15 |
| c | 0.09 | | 0.20 | 0.003 | | 0.012 |
| D | 4.90 | 5.00 | 5.10 | 0.192 | 0.196 | 0.20 |
| E | | 6.40 | | | 0.252 | |
| E1 | 4.30 | 4.40 | 4.50 | 0.169 | 0.173 | 0.177 |
| e | | 0.65 | | | 0.025 | |
| k | $0^o$ | | $8^o$ | $0^o$ | | $8^o$ |
| l | 0.50 | 0.60 | 0.75 | 0.09 | 0.0236 | 0.030 |

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